Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
Office of Engineering and Technology and Wireless Telecommunications Bureau Seek Comment Pursuant to Ray Baum's Act of 2018	)	GN Docket No. 19-128

COMMENTS OF OCEUS NETWORKS, INC.

Oceus Networks, Inc. ("Oceus Networks") respectfully submits these comments in response to the Federal Communication Commission's (the Commission) Office of Engineering and Technology's and Wireless Telecommunications Bureau's (the Bureaus) Public Notice seeking comment on bidirectional sharing as directed by Congress in the RAY BAUM'S Act of 2018.[1] With this legislation, Congress directed the Commission to "conduct a bidirectional sharing study to determine the best means of providing Federal entities flexible access to non-Federal spectrum on a shared basis" and to provide Congress with a report.[2] Over the past decade, Oceus Networks has been a leader in bidirectional sharing, a critical aspect of promoting Federal capabilities that protect national security. Oceus Networks appreciates both Congress' and the Commission's actions toward a framework enabling Federal user access to non-Federal spectrum.

[1] *Office of Engineering and Technology and Wireless Telecommunications Bureau Seek Comment on Bidirectional Sharing Pursuant to Ray Baum's Act Of 2018*, Public Notice, GN 19-128, (rel. May 1, 2019) [hereinafter *Bidirectional Sharing Public Notice*].

[2] Consolidated Appropriations Act of 2018, Pub. L. No. 115-141, Division P, Repack Airwaves Yielding Better Access for Users of Modern Services Act of 2018, Pub. L. 115-141, § 610(a)(1), 132 Stat. 1080, 1108 (2018) [hereinafter RAY BAUM'S Act]. The Public Notice recasts the statutory directive in finding that the RAY BAUM'S Act "requires the Commission . . . to submit a report that examines aspects of providing Federal entities flexible access to non-Federal spectrum on a shared basis" and that the report must "consider the regulatory certainty that commercial spectrum users and Federal entities need to make longer-term investment decisions for shared access to be viable; and . . . Evaluates any barriers to voluntary commercial arrangements in which non-Federal users could provide access to Federal entities." *Bidirectional Sharing Public Notice*, *supra* note 1, at 1.

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I. Introduction

Oceus Networks, headquartered in Plano, TX and Reston, VA, was founded on the belief that Federal spectrum users require state-of-the-art telecommunication capabilities. While Federal proprietary technologies and investment are crucial to US national security, at least equally important is the need to leverage the larger investments made in commercial 4G and 5G technologies. Providing the warfighter with state-of-the-art telecommunications equipment is necessary to ensure U.S. military superiority.

In pursuing that belief Oceus Networks has developed a wide range of wireless broadband solutions based on commercial standards, including tactical broadband, for the Department of Defense (DoD).[3] By adapting commercial standards for Federal use, Oceus Networks solved the challenge of using commercial wireless technology in military and other contexts. Our intellectual property includes critical technologies that provide security, anti-jamming, resilience, and mobility tools to the U.S. warfighter.

A prerequisite to full realization and implementation of the technological advantages of commercial wireless technologies is Federal user access to non-Federal spectrum.[4] For the past decade, Oceus Networks has pioneered bidirectional sharing technology and policy. Progress has become somewhat encouraging given that support now comes from a wide variety of spectrum stakeholders, but tangible results are still wanting. Oceus Networks submits these comments to (1) explain why Federal access to non-Federal spectrum must be made an essential part of the U.S. spectrum framework, (2) demonstrate that many high-level spectrum stakeholders and

[3] The attached appendix contains information on some of Oceus Networks' product line. *See* Appendix.

[4] Federal access to non-Federal spectrum is referred to as "bidirectional sharing" (alternatively, *bi-directional* sharing). *See* Office of Science and Technology Policy, Emerging Technologies and Their Expected Impact on Non-Federal Spectrum Demand 52, 85 (May 31, 2019); *Bidirectional Sharing Public Notice*, supra note 1 ("providing Federal entities flexible access to non-Federal spectrum on a shared basis[.]").

policymakers support implementation of bidirectional sharing, and (3) address the concerns expressed in the Bureaus' Public Notice, namely regulatory certainty and barriers to voluntary commercial arrangements.[5]

The Commission has long explored innovative forms of sharing between Federal and non-Federal users.[6] These sharing regimes further the Commission's mission of meeting the nation's commercial spectrum needs while supporting incumbent Federal uses. The Commission should also view protecting and advancing the capability of the U.S. warfighter through the adaption of commercial wireless technology as an important mission.[7] As explained in further detail below, this requires Federal access to non-Federal bands via a bidirectional sharing regime. The Commission should therefore extend its acceptance of sharing between Federal and non-Federal users toward keeping the country safe and protecting the warfighter.

II. The New Character of War Has Placed Technology at the Center of National Security and Federal Access to Non-Federal Spectrum is Another Critical Aspect

The DoD's 2018 National Defense Strategy found that "[n]ew commercial technology will change society and, ultimately, the character of war."[8] On May 15, 2019, President Trump took an important step toward protecting national security by securing the U.S. information and communications technology supply chain from foreign entities controlled by adversaries.[9] Earlier

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[5] *Bidirectional Sharing Public Notice*, *supra* note 1, at 1.

[6] For example, in the AWS-3 Order the Commission ordered that "40 MHz [is] made available for commercial use pursuant to collaboration among the wireless industry and Federal agencies." *Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands*, Report and Order, 29 FCC Rcd 4610 at ¶ 1 (2014) [hereinafter AWS-3 Order]. More recently, the Commission opened consideration of sharing in 1675-1680 between Federal and non-Federal users pursuant to congressional action promoting sharing. *Allocation and Service Rules for the 1675-1680 MHz Band*, WT Docket 19-116, Notice of Proposed Rulemaking, 84 Fed. Reg. 23,508 (2019).

[7] The 2013 DoD Electromagnetic Spectrum Strategy found that "our national leaders will be challenged to make decisions that balance national security with economic interests." Department of Defense, Electromagnetic Spectrum Strategy, Release No. NR-091-14 (Feb. 20, 2014) at 1.

[8] Department of Defense, Summary of the 2018 National Defense Strategy of the United States of America 3 (2018), https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf.

[9] *See* Exec. Order No. 13,873, Securing the Information and Communications Technology and Services Supply Chain, 84 Fed. Reg. 22,689 (May 17, 2019), *available at*

that same month the Commission took action to secure U.S. international telecommunications services from a foreign entity under the control and ownership of a foreign government.[10] These measures demonstrate the growing centrality of telecommunications and technology policy to national security; however, these actions do not holistically protect national security from the new character of war. Spectrum policy in particular must be updated to empower the warfighter in the modern era. In implementing a bidirectional sharing framework, the Commission will advance the U.S. national security posture and empower Federal users with advanced commercial technologies.

a. Bidirectional Sharing Enables Federal Users to Leverage Advanced Commercial Technology.

Commercial wireless technology can supplement existing Federal capabilities especially where a broader range of spectrum band optionality is needed. Commercial wireless manufacturers enjoy economies of scale that are unmatched by custom-developed government solutions. Large investment risk amounting to billions of dollars in research and development of new world-class wireless technology can be spread across hundreds of millions of device sales, a scale government equipment cannot match.[11] These investments have led to groundbreaking commercial products that have transformed the economy and society, but Federal users with critical missions, such as the DoD, are not able to fully leverage this commercial technology.

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https://www.federalregister.gov/documents/2019/05/17/2019-10538/securing-the-information-and-communications-technology-and-services-supply-chain.

[10] *China Mobile International (USA) Inc. Application for Global Facilities-Based and Global Resale International Telecommunications Authority Pursuant to Section 214 of the Communications Act of 1934, as Amended*, Memorandum Report and Order, ITC-214-20110901-00289 (May 9, 2019), *available at* https://docs.fcc.gov/public/attachments/FCC-19-38A1.pdf.

[11] *See, e.g.*, Cisco Systems, Inc., Quarterly Report for the Period Ended April 27, 2019 (Form 10-Q), at 4 (May 21, 2019), http://d18rn0p25nwr6d.cloudfront.net/CIK-0000858877/48fa4b1f-b0f5-45cc-b156-fd463041b162.pdf ($1.659 billion invested in research and development in second quarterly period); Qualcomm, Inc., Quarterly Report for the Period Ended March 31, 2019 (Form 10-Q), at 4 (May 1, 2019), https://investor.qualcomm.com/static-files/b6737e25-8273-4db0-9f60-5809c4352d91 ($1.308 billion in first quarterly period); Ericcson, 2018 ANNUAL REPORT, at 1 (2019), https://www.ericsson.com/assets/local/investors/documents/shareholder-information/ericsson-ar-18-10-year-summary.pdf ($38.909 billion invested in 2018).

Spectrum-dependent technology can only be adapted where Federal users have access to the broad range of spectrum that these new technologies utilize.

The United States' current strategy of spectrum management–generally excluding Federal users access to non-Federal spectrum—inhibits the DoD from unlocking the full potential of commercial technology for use in their own suite of spectrum-dependent capabilities. To maintain U.S. military superiority, warfighters must be given access to a more diverse swath of spectrum including non-Federal bands, especially at the testing, training, and exercise phases of implementing new capabilities domestically.[12] This requires a clear bidirectional sharing framework.

b. Maintaining U.S. Military Superiority Requires Federal Access to Non-Federal Bands.

As recently recognized by the Navy, spectrum is an "operational battle space[.]"[13] Military superiority is increasingly dependent on advanced technological capability. Spectrum-dependent systems such as high resolution radar, agile datalinks, drones, and battlefield radios are critical tools for the warfighter.[14] Cloud computing, artificial intelligence, and other data-driven technologies are also central to military activities and have growing bandwidth needs.[15] But current U.S. policy does not fully support a cohesive national security spectrum strategy.

Combat in this new operational battlespace is becoming easier for adversaries to conduct with the advent of high-tech, low-cost gear.[16] U.S. commercial operations are built on a spectrum

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[12] DoD Chief Information Officer, Written Response, https://dodcio.defense.gov/Portals/0/Documents/Spectrum/Bilateral_Sharing.pdf.

[13] Department of the Navy, SECNAV Instruction 2400.3 (Oct. 5, 2018), https://www.secnav.navy.mil/doni/Directives/02000%20Telecommunications%20and%20Digital%20Systems%20Support/02-400%20Visual%20Information%20Services/2400.3.pdf.

[14] DoD Chief Information Officer, *supra* note 12.

[15] Sebastian Moss, *DoD Outlines Cloud Strategy, Focuses on JEDI and Military AI*, Data Center Dynamics (Feb. 5, 2019), https://www.datacenterdynamics.com/analysis/dod-outlines-cloud-strategy-focuses-jedi-and-military-ai/.

[16] DoD Chief Information Officer, *supra* note 12. Industry members have also recognized the growing dangers of next-generation warfare, for example, SpaceX recognized "[t]he need for spectrum for warfighting capabilities is

community that is predictable and regulation compliant, but warfare is not conducted in a cooperative spectrum environment. Successful modern military operations require adaption in chaotic environments. By relegating Federal operations to certain bands and limiting access to non-Federal bands, U.S. spectrum policy hinders the warfighter's ability to fight in this new domain.

Federal access to non-Federal spectrum through bidirectional sharing enables technological adoption and mastery of advanced commercial technologies in diverse spectrum bands, including non-Federal bands, which are required on the modern battlefield.[17] Without it, there is insufficient ability to produce, test, and implement these critical warfighter tools domestically. In voting to secure US networks, Chairman Ajit Pai held that "[w]hen it comes to our national security, we cannot afford to make risky choices and just hope for the best. We must have a clear-eyed view of the threats that we face and be prepared to do what is necessary to counter those threats."[18] A similar strategy should be adopted here.

c. Bidirectional Sharing Enhances Cybersecurity.

Bidirectional sharing also furthers effective cybersecurity. During its May 2019 Open Commission Hearing, both Democratic and Republican Commissioners stressed the need for increased attention to security regarding the nation's telecommunications network.[19] Bidirectional

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growing, but even beyond that direct need, our country is also increasingly vulnerable to Electronic Warfare threats. . . DoD must have the spectrum resources necessary to combat these forces across multiple spectrum bands." Space Exploration Technologies Corp., Comments Before the National Telecommunications and Information Administration, Docket No. 181130999-8999-01, at 11 (Jan. 29, 2019), *available at* https://www.ntia.doc.gov/files/ntia/publications/spacex_comments_re_national_spectrum_policy.pdf.

[17] *See* discussion *supra* section II.a.

[18] *China Mobile International (USA) Inc. Application for Global Facilities-Based and Global Resale International Telecommunications Authority Pursuant to Section 214 of the Communications Act of 1934, as Amended*, ITC-214-20110901-00289, at 22-23 (May 9, 2019), *available at* https://docs.fcc.gov/public/attachments/FCC-19-38A2.pdf.

[19] *See id.* at 22-35.

sharing enhances cybersecurity for Federal users because a government-controlled private LTE network directly enables use of Commercial Solutions for Classified tactical security measures.

d. Bidirectional Sharing Enhances Public Safety by Encouraging Infrastructure Buildout to Rural Areas.

The Digital Divide has been identified as a top priority by the Executive, Congress, and the Commission.[20] A bidirectional sharing framework furthers wireless coverage to rural areas by creating infrastructure where operators have typically had difficulty building out due to economic limitations. Currently, spectrum policies limit the ability of non-traditional operators to construct private networks due to the inability to access spectrum. As a consequence, rural communities are left disconnected, which is especially dangerous during times of crisis. Federal activities in rural areas using a private cellular LTE network would provide an option for rural connectivity for public safety purposes, thus better protecting vulnerable populations.

III. Support for Bidirectional Sharing across Spectrum Stakeholders and Policymakers is Growing.

During the AWS-3 proceeding the Commission considered "whether Federal users should be able to access the AWS-3 band(s)" including the non-Federal segments.[21] The Commission noted that "shared use of spectrum bands by Federal and non-Federal users could facilitate the increased use of 'commercial-off-the-shelf' (COTS) communication technologies to support important government missions, including military uses[.]"[22] There was support for this proposal,[23] but action on this issue in the final order was deferred at the request of the National

[20] *See* Connecting Broadband Deserts Act, H.R. 55, 116th Cong. (2019); Exec. Order 13,821, 83 Fed. Reg. 1,507 (Jan. 8, 2018), *available at* https://www.federalregister.gov/documents/2018/01/11/2018-00553/streamlining-and-expediting-requests-to-locate-broadband-facilities-in-rural-america; Ajit Pai, Bridging the Digital Divide (July 13 2017 2:55 PM), https://www.fcc.gov/news-events/blog/2017/07/13/bridging-digital-divide.

[21] *Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands*, Notice of Proposed Rulemaking ¶ 81 (July 23, 2013).

[22] *Id.*

[23] *See* Letter from Michael Calabrese, New America Foundation Open Technology Institute to Marlene H. Dortch, Secretary, FCC, Notice of Ex Parte Presentation, at 2 (Mar. 24, 2014) (showing "strong support" for "permitting

Telecommunications and Information Administration (NTIA) and DoD.[24] Five years have lapsed since that order, and the Commission has taken no action towards enabling Federal access to non-Federal bands despite explicit support from many spectrum stakeholders and policymakers including the President, the DoD, and Industry stakeholders. The underlying need for such access, including more effective combat in Electronic Warfare and enabling greater warfighter capability, is not advanced under the current framework.

a. The President

The October 25, 2018 *Presidential Memorandum on Developing a Sustainable Spectrum Strategy for America's Future* established as policy of the United States that the "government shall continue to look for additional opportunities to share spectrum among Federal and non-Federal entities" and "encourage investment and adoption by Federal agencies of commercial, dual-use, or other advanced technologies that meet mission requirements, including 5G technologies."[25] The Presidential Memorandum also directed the Secretary of Commerce to include in his National Spectrum Strategy proposal recommendations towards greater spectrum access with "improved cooperation and collaboration between Federal and non-Federal spectrum stakeholders[,]"[26] Oceus Networks strongly supports the President's call to support Federal adoption of next-generation technologies via shared spectrum. A necessary step toward this goal is Federal access to non-Federal spectrum.

Federal users, particularly the military, to use fallow spectrum in the 1755-1780 and 2155-2180 MHz bands post-auction."), *available at* https://ecfsapi.fcc.gov/file/7521095042.pdf.

[24] AWS-3 Order, *supra* note 6, at ¶ 202.

[25] Developing a Sustainable Spectrum Strategy for America's Future, 83 Fed. Reg. 54,513, 54,513-14 (Oct. 25, 2018), *available at* https://www.govinfo.gov/content/pkg/FR-2018-10-30/pdf/2018-23839.pdf.

[26] *Id.* at 54,514.

b. Department of Defense

Frederick D. Moorefield, the DoD Deputy Chief Information Officer for Command, Control, Communications and Computer and Information Infrastructure Capabilities, advocated for bidirectional sharing as early as 2015 noting that Federal users already share spectrum efficiently and that a framework must be put in place to enable Federal access to non-Federal spectrum.[27]

The DoD has publicly identified the "inevitable need" for bidirectional sharing due to the increasing bandwidth needs of advanced warfighting capabilities, rising in tandem with the threat of Electronic Warfare.[28] The DoD has advocated for greater bidirectional sharing through the National Spectrum Consortium, the Spectrum Access Research and Development Program, and the National Advanced Spectrum Communications Test Network.[29] Oceus Networks supports these measures and urges the Commission to continue the DoD's momentum toward protecting national security.

c. Industry

Leaders in commercial wireless have also been active in the promotion and adoption of bidirectional sharing, most recently in response to the NTIA's Request for Comments on the National Spectrum Strategy. Elefante Group, a manufacturer of stratospheric aerial communications platforms, works with a number of Federal agencies toward leveraging investment it has made in sharing and is ready to assist them "in any way reasonable and

[27] Finding that "bi-directional sharing is important to further advance spectrum policy for sharing that facilitates sharing opportunities with Federal users . . . DoD envisions a framework to expand the boundaries of sharing to increasingly include Federal access to non-Federal bands as well as vice-versa[.]" Frederick Moorefield, TIA 2015 Keynote: Fred Moorefield, Dept. of Defense CIO Office, *available at* https://www.tiaonline.org/video/tia-2015-keynote-fred-moorefield-dept-of-defense-cio-office/ (references begin at 15:59).
[28] DoD Chief Information Officer, *supra* note 12.
[29] *Id.*

practical."[30] Google has advocated for automated bidirectional sharing "between Federal and non-Federal users" in specific bands.[31] SpaceX has observed that Federal and non-Federal spectrum users "have gradually begun to embrace the reality that to accomplish our various missions, we all will need to move past historic distrust and leverage instead the advanced technology that enables more sharing" and that "to ensure sufficient spectrum for Federal and non-Federal use, a comprehensive National Spectrum Strategy must set out a flexible framework for bidirectional sharing."[32]

All of these entities recognize a fundamental truth about spectrum policy: For a successful future where all U.S. spectrum users have adequate access, spectrum management cannot remain in a culture of rigid protectionism and exclusion. It instead must become a collaborative community built on technology and trust.[33] As Congress has mandated the Commission to study the best means of implementing a bidirectional sharing framework, the Commission should use these principles in design and implementation.

IV. Promoting Regulatory Certainty via Federal Access to Non-Federal Bands.

a. Federal Entities Need Regulatory Certainty; Voluntary Commercial Arrangements are Not an Adequate Method of Providing Federal Users Access to Non-Federal Spectrum.

Congress asked the Commission to "consider the regulatory certainty that commercial spectrum users and Federal entities need to make longer-term investment decisions for shared

[30] Elefante Group, Inc., Comments Before the National Telecommunications and Information Administration, Docket. No. 18113099-8999-01, at 18 (Jan. 29, 2019), *available at* https://www.ntia.doc.gov/files/ntia/publications/elefante_group_ntia_nss_comments_final_1-22-19.pdf.
[31] Google LLC, Comments Before the National Telecommunications and Information Administration, Docket. No. 18113099-8999-01, at 9 (Jan. 29, 2019), *available at* https://www.ntia.doc.gov/files/ntia/publications/2019-01-22_google_comments_dkt._181130999-8999-01_rin_0660-xc044.pdf.
[32] Space Exploration Technologies Corp., *supra* note 16.
[33] *Id*. (citing Frederick D. Moorefield. DoD Spectrum Evolution Brief to IEEE Broadcast Symposium (Nov. 27, 2017)).

access to be viable[.]"[34] In making acquisition determinations, Federal users need assurance that investments in expensive and long-term spectrum-dependent applications will not be rendered useless due to a lack of spectrum access. Oceus Networks has experienced how lack of certainty in spectrum access has limited DoD adoption of commercial wireless technology. Without access to non-Federal bands that support commercial wireless, especially during the testing and exercising phases, the U.S. military has not been able to make large investments in certain national security applications. Similarly, defense manufacturers such as Oceus Networks have limited access to non-Federal bands during research and development, thus inhibiting development of those capabilities. This lack of spectrum access certainty poses a serious detriment to the warfighter and threatens U.S. military superiority.

Currently, Federal access to non-Federal bands is limited to voluntary commercial arrangements at the discretion of non-Federal licensees. Oceus Networks has entered into arrangements and has partnered with national wireless carriers in secondary market transactions in the past. However, such arrangements are limited in time and geography, and are difficult to negotiate. This is a barrier to the development and adoption of military tactical wireless systems due to the uncertain availability of accessing the spectrum these systems need domestically.

b. Federal Access to Non-Federal Spectrum can be Accomplished with Tightly Circumscribed Interference to Commercial Operations.

Testing and training of new national security applications largely occurs in remote and sparsely populated parts of the United States. These areas have historically, and are currently, neglected by wireless broadband licensees.[35] Therefore, the risk of harmful interference to commercial services is minimal. Commercial providers have argued in the past that if Oceus

[34] RAY BAUM'S Act, *supra* note 2, at (§610(b)(1)).
[35] *See generally*, National Broadband Map, *available at* https://broadbandmap.fcc.gov/#/.

Networks were to construct and manage a wireless network on a secondary basis in a licensed market, such a network would inhibit a licensee from expanding coverage into that area.[36] This is untrue because secondary users—including the military during training exercises—are required by rule to cease operations should interference occur with the primary leaseholder's operations.[37]

As noted by Google in its comments to the National Spectrum Strategy: "Modern spectrum sharing can augment utilization while still protecting against harmful interference."[38] This is true for all sharing frameworks, including bidirectional sharing. Spectrum users find innovative ways to make the most of spectrum made available to them, even when sharing with others. A forward-looking bidirectional sharing model can provide guaranteed access for Federal users in non-Federal bands by leveraging advances in spectrum sharing technology. Such certainty will expedite the development of new national security applications to protect and enhance the warfighter.

V. Conclusion

Oceus Networks thanks the Commission and Congress for their attention to the promotion of bidirectional sharing. DoD's 2013 Electromagnetic Spectrum Strategy, now six years old, recognized that "policy and regulatory changes are needed to improve spectrum access, including DoD access to spectrum allocated in the United States for non-federal use."[39] Momentum for bidirectional sharing is building. Government and industry both recognize it as an important step in reaching a truly forward-thinking and innovative spectrum strategy that furthers the missions of

[36] *See* Letter from Stacey G. Black, AT&T, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 13-185 (March 20, 2014), *available at* https://ecfsapi.fcc.gov/file/7521094197.pdf.
[37] Additionally, "[u]nlike a commercial network, tactical architectures are often composed of highly mobile and portable elements, and could be moved to other suitable training locations." Letter from Douglas C. Smith, Oceus Networks, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 13-185 (Mar. 24, 2014), *available at* https://ecfsapi.fcc.gov/file/7521094891.pdf.
[38] Google, *supra* note 31, at 2.
[39] Department of Defense, *supra* note 7, at 7.

both Federal and non-Federal spectrum users. All spectrum users need regulatory certainty for safe investment and access to adequate spectrum to complete their missions. The Commission should advance these goals by enabling and encouraging a strong and cooperative bidirectional sharing framework. Such a framework is in the public interest of the United States as it promotes national security, economic security, and technological innovation.

APPENDIX

OCEUS NETWORKS PRODUCT LINE

Oceus Networks, Inc. provides customized broadband products and solutions to government and enterprise customers across the globe with the latest in standards-based commercial technology. We specialize in the delivery of mobile solutions, integrating fixed and wireless broadband technologies that enable secure, high-speed voice, video, and data communications. Our solutions enable improved situational awareness, provide for a collaborative environment, and provide automated Primary, Alternate, Contingent, and Emergency (PACE) communications within a Disconnected, Intermittent, and Latent (DIL) environment.

Sample Products (more information attached):

Xiphos® Macro, Private cellular Macro

- 3GPP compliant, 4G LTE network
- Local application server, enables federated tactical services
- Rugged hardware
- 10”x16”x16.4”, 47 lbs
- 2x2 MIMO, 2x40W

Xiphos ® Micro, Private cellular Micro

- 3GPP compliant, 4G LTE network
- Local application server, enables federated tactical services
- Ruggedized hardware11”x15”x4.5”, 19 lbs
- 2x2 MIMO, 2x5W

Xiphos ® XMACV, Private cellular EPC

- Full EPC functionality from a Virtual core, runs in a single virtual machine

ONmission ®, Tactical cellular network planning

- RF planning for non-RF engineers
- Designed for tactical environment where both eNodeB and subscribers are mobile

ONcast, point-to-point VPN

- Operates as a secure virtualized switch, allowing clients and servers located anywhere on the routed IP network
- Support for Linux, iOS, Android, Windows

OCEUS NETWORKS

Networking for a Better Tomorrow

Oceus Networks Xiphos® Macro

SCALABLE AND RAPIDLY DEPLOYABLE 4G LTE COMMUNICATION SOLUTIONS

Xiphos® Macro Main Unit with Radio 2217 Top Mount

Secure communications and accurate situational awareness are key to any size mission. The next generation of Xiphos® Macro is the most powerful and flexible member of the Xiphos family of products and optimized for larger scale deployments.

Xiphos Macro is a tactical, ruggedized (MIL Standard) and scalable on-the-move 4th Generation (4G) Long Term Evolution (LTE) / 5G New Radio (NR) broadband solution that can operate in a stand-alone or networked environment.It is highly scalable and provides high data throughput, operating as a compact system to a small group of users in a defined coverage area, or a high capacity configuration that services a large number of users within a wide coverage area.

Xiphos Macro is based on Ericsson's world leading LTE macro radio technology, which delivers superior RF output power and range, providing 5-7 miles of range in a typical tactical environment and over 50 miles of range for airborne deployments with a clear line of sight.

The optional Advanced Network of Xiphos (ANOX) capability enables on-the-move systems to recognize each other and make intelligent decisions on how to work together to provide the best connectivity to end-users.

Xiphos Macro is a robust system with features and functionality that empowers

XIPHOS

Key Benefits

Mission-Critical Operations: Supports mission-critical operations by providing users access to fast mobile broadband connectivity.

Easy-to-Use: Installs easily, operates autonomously and powers up fast for operation in minutes.

Flexible Rugged Configurations: Xiphos is based on rugged modular HW components that provide deployment flexibility and scalability.

Based on Commercial Technology: The use of standards-based carrier grade commercial 4G LTE technology in Xiphos allows customers to leverage industry innovation and economies of scale to lower costs and to equip users with best-of-breed tools, applications and smartphones.

High Capacity Data Transfer: Xiphos Macro's high capacity enables applications to transfer large amounts of data in a fast and cost efficient manner.

Multitude of LTE Frequencies: Supports a full range of Frequency Division Duplex (FDD) and Time Division Duplex (TDD) frequency bands, and it is compatible with commercial 4G LTE devices.

LTE Frequency Flexibility: Supports concurrent use of up to three (3) different frequency bands per system. This allows customers to quickly adapt to an LTE frequency suited for a particular country/region and mission, and it enhances the interference resilience of the solution.

Network Scalability: Xiphos Macro can be deployed in a Network of Xiphos (NOX) configuration, allowing users to move between coverage areas while maintaining already established sessions. This provides flexible network scalability by increasing the aggregated coverage area, data throughput and concurrent connected radio sessions for each deployed system.

Advanced Network Of Xiphos (ANOX): The ANOX architecture allows a swarm of Xiphos systems on the move to dynamically learn about the presence of other Xiphos peer systems, and to make intelligent decisions on how to optimize network connectivity between them.

Interference Detection: Xiphos Macro detects LTE RF interference and displays an alarm on the dashboard.

SON and QoS: Xiphos Macro provides sophisticated carrier-grade functionality, such as support for Quality of Service (QoS), policy management and enforcement, Self Organizing Network (SON), priority and pre-emption handling and radio interface optimization.

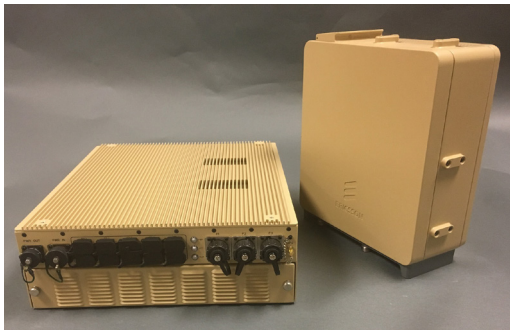
HARDWARE COMPONENTS

Xiphos Macro's hardware design consists of ruggedized Main Unit and new lighter outdoor radios with pole mounting, rail mount, or tower mount.

- **Main Unit Module:** Contains the Enhanced Packet Core (EPC), Home Subscriber Server (HSS), Policy and Charging Rules Function (PCRF) (optional) and O&M software, and the LTE baseband processing unit. It allows up to three sectors operation.
- **Radio 2217/2203/4478:** Supports MIMO operation.
- **Site Solutions**

  Transit case kit for MU
  TFOCA case for MU and radios
  Optional radio fan kit
  Radio pole mounting kit
  Radio docking (to MU) kit
  Radio power unit kit
  Optical cabling kits

Radio 2217



Xiphos® Macro Main Unit

FIGURES AND FACTS	SMALL	MEDIUM	LARGE		
Main Unit:	**Radio 2203:**	**Radio 2217:**	**Radio 4478:**	**LTE Frequency Bands (*):**	**Environmental:**
Size (HxWxD)	Size (HxWxD)	Size (HxWxD)	Size (HxWxD)	(*) Not all frequencies are available for all radio types	Temperature High
Weight	Weight	Weight	Weight		Temperature Low: Radio
Power Input	Power Input	Power Input	Power Input		Temperature Low: Main Unit
Power Consumption	Power Consumption	Power Consumption	Power Consumption		MIL 810G
System Processor	Number of RF sectors	Number of RF sectors	Number of RF sectors		EMI, FCC, Part 15A
Application Processor	System Throughput Mbps (DL/UL)	System Throughput Mbps (DL/UL)	System Throughput Mbps (DL/UL)		
Number of RF sectors	RF Output Power	RF Output Power	RF Output Power		
Concurrent RF sessions					
XIPHOS MACRO 4.0					
5.2"x16"x16.4"	8"x8"x4"	13.8"x11.7"x5.4"	18"x13.5"x7.8",	2100 (1),1900 (2),	131F/55C
37 lbs	10 lbs	28 lbs	56 lbs	1800 (3,3A),17/2100 (4),	-40F/-40C
100V to 240V AC	-48V DC	-48V DC	-48V DC	800 (5), 2600 (7),	-4F/-20C
<400W	<150W	<350W	<602W	900E (8), 700 (12,13,14,17)	Compliant
Quad-core Processor, 2.4 MHz, 32 GB RAM, 1 TB SSD	1 MIMO Sector	1 MIMO Sector	1 MIMO Sector	800 (20), 1900 (25),	Compliant
Quad-core Processor, 2.4 MHz, 32 GB RAM, 2 TB SSD	150/75 Mbps	150/75 Mbps	150/75 Mbps	850 (26A),	
3 MIMO Sectors	Up to 2*5W (LTE band dependent)	Up to 2*40W (LTE band dependent)	Up to 80W	700 (28A,28B,28C),	
2000			Band 14, 2TX/2RX and 4TX/4RX	2600 (38), 1900 (39),	
			2*40W and 4*40W	2300 (40,40A,40U),	
				2600 (41)	

To learn more about Oceus Networks' Xiphos solutions, visit: www.oceusnetworks.com

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Oceus Networks
Xiphos® Micro 3

TACTICAL, LIGHTWEIGHT MAN-PORTABLE 4G LTE COMMUNICATION SOLUTION

Xiphos® Micro 3

From remote battlefield operations to urban emergencies, mission success depends on optimal situational awareness. Xiphos® Micro delivers a mobile and reliable broadband network when communications infrastructure is inadequate, damaged or non-existent in the most challenging environments.

Xiphos Micro, the latest extension of Oceus Networks' proven Xiphos mobile communications solutions, is a small form-factor 4th Generation (4G) Long Term Evolution (LTE) self-contained network. Optimized for tactical, on-the-move operations, Xiphos Micro provides mobile broadband quickly in situations where no other suitable network exists or a private network is desired.

Xiphos Micro is a reliable, easily-deployable broadband system that enables high-speed voice, video and data communications to facilitate complex operations and addresses the immediate communication and data requirements of mobile field personnel. It is optimized for reduced size, weight and power (SWAP) consumption. Its rugged, military grade (MIL-STD-810G) compliant construction, coupled with the latest technology and security features, makes it ideal for a wide variety of battlefield, remote location and emergency-responder situations.

Xiphos Micro allows users to augment, or potentially replace, cost-prohibitive equipment with Commercial Off-The-Shelf (COTS) cellular hardware.

XIPHOS

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Key Benefits

Mission-Critical Operations: Xiphos Micro provides users access to fast, mobile broadband connectivity in mission-critical operations.

Easy-to-Use: Installs easily, operates autonomously, and powers up fast for operation in minutes.

Reduced Footprint and Power Consumption for Man-Portable Operations: Provides operation of a complete 4G LTE self-contained network that includes a micro eNodeB optimized for use in situations where reduced footprint and power consumption, and mobility are driving factors.

Ruggedized Hardware: Ruggedized for harsh environments and MIL Standards-compliant construction.

Based on Commercial Technology: Reduces costs and allows users to benefit from best-of-breed tools, applications and smart phones. Built on standards-based, commercial 4G LTE technology to leverage industry innovation and economies of scale.

High Capacity Data Transfer: High data throughput enables many in demand applications, such as NSA Compliant secure Commercial Solutions for Classified (CSfC) dual-tunnel encryption; biometrics; databases; Intelligence, Surveillance and Reconnaissance (ISR); positioning and sensor data; situational awareness and collaboration; streaming HD video and Voice over IP.

Enables Local Applications: Embedded server platform runs applications locally in a virtualized environment.

Advanced Network of Xiphos (ANOX): The ANOX architecture allows a swarm of on-the-move Xiphos systems to dynamically recognize other Xiphos peer systems, and make intelligent decisions how to optimize network connectivity.

Additional Outputs:
- Output Power for MANET Backhaul
- SAASM GPS

XIPHOS MICRO HARDWARE

Xiphos Micro is ruggedized and optimized for portability when reduced size, weight and power consumption is important for the last mile deployment. Micro consists of the following main components:

System Unit
- Micro LTE eNodeB with 2x5W RF Output Power
- MIL-STD 810G Compliant
- Server Platform for Evolved Packet Core (EPC), Home Subscriber Server (HSS), and O&M SW, with Virtualized Space for Local Applications
- GPS
- Status Indicators
- Radio On/Off Button
- Emergency Zero Button Renders Unit Non-Operational
- Fan-less Cooling
- Up to Two (2) Military Grade Field Swappable Batteries or military 28V DC input vehicle power support
- Provides Up to Six (6) Hours Operation

Deployment Solutions
- Vehicle Mount/Dismount Solution
- Dismounted - Ergonmic Pack with Battery Pouches
- Mast Mount Site Solution

Field Kits
- Rugged Transport Case
- AC Power Supply
- AC/DC Outdoor Power Supply
- Battery Charger
- Cabling, Antennas, Connectors

To learn more about the Oceus Networks Xiphos solution, visit:
www.oceusnetworks.com

FIGURES AND FACTS	XIPHOS MICRO 3
Dimensions: Size (HxWxD) Weight	 11”x15”x4.5” 19 lbs
Power: Power input Power consumption	 28 VDC <100W
Capacity (max values): LTE eNodeB Bandwidth RF Output Power DL Mbps UL Mbps Concurrent Connected RF Sessions	 1 Micro eNodeB 5, 10, 15, 20 Mhz 2x5W 140 40 64
LTE Frequency Bands (MHz):	1900 (2), 1800 (3), 700 (28), additional custom bands per customer requirements
3GPP Standard	RAN: Release 11, Core: Release 13
Environmental: Temperature High Temperature Low MIL 810G EMI, FCC Part 15, Class B	 122F/50C -4F/-20C Compliant Compliant

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OCEUS NETWORKS

Networking for a Better Tomorrow

Oceus Networks
Xiphos® Macro - Virtualized

COMPACT AND RAPIDLY DEPLOYABLE OUTDOOR SOLUTION UTLIZING A VIRTUAL EPC

XMAC-V OUTDOOR BASEBAND 6303 POLE MOUNT

Reliable communications systems are essential to success for on-the-move ground teams. Xiphos® Macro Virtualized is a tactical, compact 4G/5G LTE RF Macro system optimized for deployment where reduced size, weight and power consumption are driving factors.

Xiphos Macro Virtualized (XMAC-V) is a complete 4G Long Term Evolution (LTE) / 5G New Radio (NR) solution that offers full flexibility in deployments. It provides mobile broadband quickly in areas where no other suitable network exists or a private network is desired. The XMAC-V offers an outdoor Macro radio solution that is connected to a virtualized core network which provides a future-proof solution.

XMAC-V is based on Ericsson's world leading LTE radio technology, which provides superior RF output power, range, and performance.

XMAC-V provides a complete on-the-move LTE system for critical missions and has been designed for a virtualized environment for secure, high-speed voice, video and data communications to the tactical edge.

XIPHOS

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Key Benefits

Mission-Critical Operations: XMAC-V supports mission-critical operations by providing users access to fast mobile broadband connectivity.

Easy-to-Use: Installs easily, operates autonomously and powers up in minutes.

Based on Commercial Technology: The use of standards-based carrier grade commercial 4G/5G technology, XMAC-V allows customers to leverage industry innovation and economies of scale to lower costs and to equip users with best-of-breed tools, applications and smartphones.

High Capacity Data Transfer: High data throughput enables many applications in demand, such as biometric information; databases; Intelligence, Surveillance and Reconnaissance (ISR); positioning and sensor data; situational awareness and collaboration; streaming HD video and Voice over IP.

Multitude of Frequencies: Supports a wide range of FDD and TDD bands, and it is compatible with commercial 4G LTE devices.

Network Scalability: XMAC-V can be deployed in a Network of Xiphos (NOX) configuration, allowing users to move between coverage areas while maintaining already established sessions. This provides flexible network scalability by increasing the aggregated coverage area, data throughput and concurrent connected radio sessions for each deployed Xiphos system.

Advanced Network of Xiphos (ANOX): ANOX allows Xiphos systems to work together. It detects connectivity between units, synchronizes key elements and contains algorithms that adjust various elements in real-time to provide the best connectivity to the end-user.

Interference Detection: Detects RF interference and displays alarms on the operations & maintenance (O&M) dashboard.

Carrier Grade Features and Functions: Supports the latest features being deployed in the most advanced carrier networks. This includes support for Quality of Service (QoS), policy management and enforcement, Self Organizing Network (SON), priority and pre-emption handling and radio interface optimization.

XIPHOS MACRO VIRTUALIZED

The Xiphos Macro Virtualized is optimized for reduced size, weight and power consumption while still providing Macro RF capability.

XMAC-V is a complete outdoor baseband and radio solution with virtualized core network functionality that is easily installed and configured on customer's virtual network.

The system contains the following main components:

- Macro Radio Unit with AC output power, frequency band dependent.
- 6303 outdoor baseband processer.
- VIrtulaized Sofware for Evolved Packet Core (EPC), Home Subscriber Server (HSS), and O&M SW.

RADIO 2203 AND 2217

FIGURES AND FACTS	XIPHOS MACRO VIRTUALIZED		
Basedband 6303 Dimensions: Size (HxWxD) Weight	10.5" x 8" x 4" 12 lbs	**Environmental:** Temperature High Temperature Low EMI, FCC Part 15, Class A	 131F/55C -40F/-40C Compliant
Power: Power input Nominal Voltage	110V AC 100-250V AC		
Configuration Support: Supported Radio Interface Connections Maximum number of Cells (FDD/TDD) Supported bandwidths Maximum number of radios per cascade chain	 Three (3) radio ports Twelve (12) 1.4, 3, 5, 10, 15, or 20 MHz Six (6)		
LTE Radios*: 2203, 2212, 2217, 2219, 4412, 4478 (*) Not all frequencies are available for all radio types	**LTE Frequency Bands (MHz):** 2100 (1),1900 (2),1800 (3),17/2100 (66A),800 (5),2600 (7),700 (12,14,17,28),800 (20) 2600 (41),3500 (48), 600 (71), additional bands per customer requirements,		
Xiphos Virtualized Core Resources **Supports** **ESXI Version** vCPUs Logical CPUs Hardware CPU **RAM** Minimum Recommended **Storage** Xiphos VM ESXi Snapshots	**Small Configuration** • <100 users; • Single eNodeB/Single Cell • 6.5 update 1 or newer • Four (4) - 2 Sockets/2 Cores per socket with hyperthreading • Four (4) • Dual Core i7 @ 2.20 GHz or better 8GB 16GB 250GB 120GB 10GB 120GB	**Medium Configuration** • 100-500 users; • Single eNodeB/up to 3 Cells • 6.5 update 1 or newer • Eight (8) - 4 Sockets/2 Cores per socket with hyperthreading • Eight (8) • Quad Core i7 3770 @ 3.4GHz or better 8GB 16GB 250GB 120GB 10GB 120GB	**Large Configuration** • >500 users; • Two (2) eNodeB/up to Six (6) Cells • 6.5 update 1 or newer • Eight (8) - 4 Sockets/2 Cores per socket with hyperthreading • Eight (8) • Quad Core i7 6700TE @ 2.4GHz or better (i7-6700 @3.4GHz preferred) 16GB 32GB 250GB 120GB 10GB 120GB

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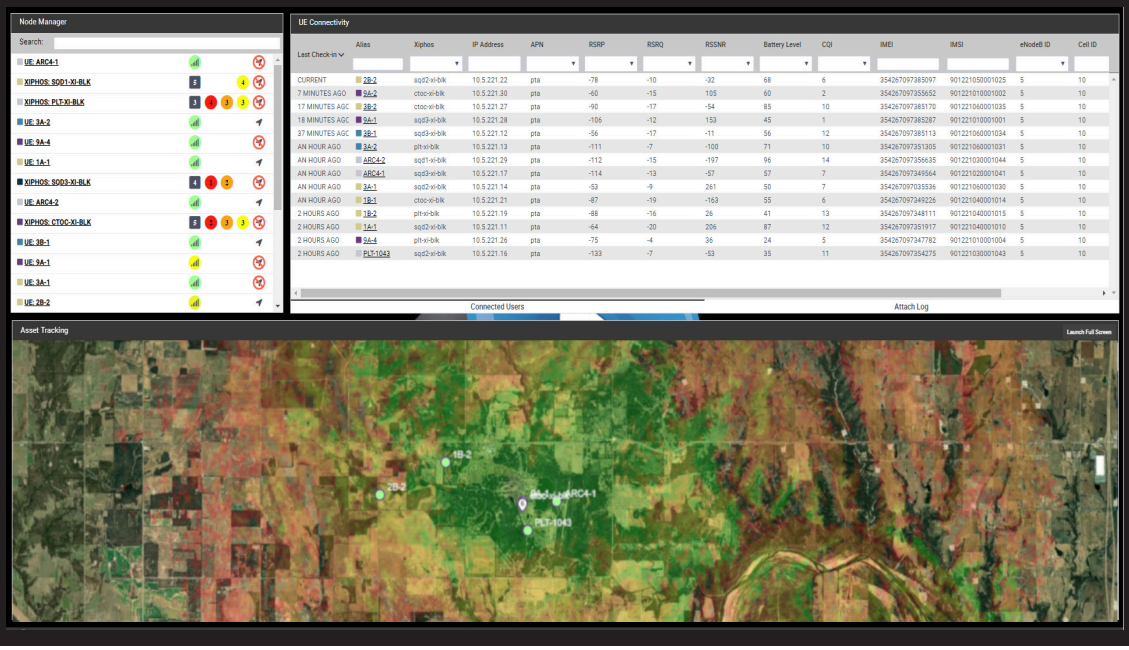
OCEUS NETWORKS

Oceus Networks ONmission™ with SensorNET

END-TO-END MOBILE NETWORK PERFORMANCE MANAGEMENT



- NODE MANAGEMENT
- UE CONNECTIVITY MONITORING
- RF ENVIRONMENTAL SA
- ROGUE UE & eNodeB DETECTION
- BACKHAUL CONNECTIVITY
- ASSET TRACKING

MOBILE NETWORK MANAGEMENT CONTROL FOR BATTLEFIELD, CRITICAL INFRASTRUCTURE AND EMERGENCY RESPONSE SITUATIONS.

ONmission

Optimal situational awareness is essential to understanding how information, events and actions will impact mission-critical goals and objectives. Providing secure tactical communications can be difficult on the battlefield, in remote locations and in emergency response situations where infrastructure is sparse or damaged. In these environments, reliable management of both the network infrastructure and end user devices is mandatory.

ONmission™ is a Situational Awareness (SA), Network Management, and Device Management System for mobile and fixed networks that provides Sensor IoT, RF SA, and traditional Network Management controls, plus customizable modules for specific customer requirements.

ONmission was developed to easily integrate with all types of networks including cellular wireless, MANET, SATCOM, WiFi, and wired networks.

The ONmission user interface was developed from the ground up to provide a superior user experience and leverages the latest web technologies.

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Key Benefits

Ease of Use: ONmission is designed from the ground up with the user experience in mind. The solution works as an E2E engine that collects, processes and reports network and subscriber metrics for on-the-move mobile networks.

SensorNET: Intuitive UI for quick analysis of the network, provides SA that quickly identifies events. Provides a SA Map View with RF propagation and location, actual device signal strengths, battery levels and other key sensors for device SA.

Network Management: ONmission's Network Management Platform provides traditional network monitoring of traffic using node grouping, node status and node monitoring (SNMP or PING), alarms, traffic, and multiple network views to ensure a secure and reliable network environment.

Tactical Device Management Platform (TDMP): ONmission's tactical device management platform gives the operator the ability to remote wipe, remote lock, push applications and locate devices. TDMP is effective for locating, tracking, and transmits sensor information from the UE without interfering with the operation of the UE. Data can also be cached and metrics analyzed which extends the operators view all the way to the edge.

RF Planning: Designing an RF coverage prediction map is a difficult task, even for an experienced RF specialist. ONmission provides a user friendly and intuitive web-based RF Planning component that simplifies the task by enabling customers to generate predictive coverage for individual or multiple cells in a few minutes with a minimal amount of input needed.

Flexible Performance Monitoring: ONmission is a flexible E2E system that monitors a mobile networks service performance with an easy to use self-service dashboard for display of alarms, subscribers, statistics, and system health.

Xiphos Management: ONmission is designed to easily manage a wide range of Xiphos deployments and provides a unified interface for Network of Xiphos (NOX) configurations.

ONmission

ONMISSION R4 FEATURES

SensorNET

- Intuitive UI for quick analysis of the network and SA
- SA Map View with projected RF propagation and location, actual device signal strength, battery levels and other key sensors for device SA
- Artificial Intelligent (AI) algorithms to quickly identify events
- Ingests statistics from all network elements via various protocols for complete network SA
- Inter-link statistics for backhaul SA

Network of Xiphos (NOX) Platform

- Concurrently manage multiple Xiphos solutions
- Interference and jamming detection
- Simplified NOX integration and configuration
- Multiple live map views
- Multiple users' data display
- Multiple systems data display
- Single device statistics
- System information display
- Single point of access to all Xiphos node sub-interfaces
- System location display
- System health display
- Multiple NOX support
- Xiphos subscriber status
- Xiphos system management
- Real-time maps for location of both mobile and static Xiphos systems

Network Manager Platform

- Supports SNMP v1, 2c, 3 nodes
- SNMP Monitoring
- MIB Handling (individual or bulk)
- Visible node position and status on map view
- Node grouping: Hierarchical multi-level node display
- Alarm manager: Configuration and control of alarm handling and display
- Alarm page with notes per alarm
- Consolidated alarm view of multiple nodes
- Real-time alarm view and filter capability
- Alarm event history
- System location display
- System health display
- Team analysis and collaboration tool
- Event logging
- Report generation tool
- Report SSO
- SNMP based graphing tool
- In-browser SSH and Telnet management
- In-browser network troubleshooting (traceroute and ping)

RF Planning

- RF coverage plotting and analysis
- Web Map Service (WMS) server support
- Map Scale
- Maps Keyhole Markup Language (KML) support

Tactical Device Management Platform

- Device Location on Maps /Tracks
- Over-the-Air (OTA) programming
- Android™ device management
- Add, remove, change, wipe, lock and/or block device(s)
- List device data
- Push applications and certificates
- Group mobile device provisioning
- Mobile device location query
- MDM "Light" (Reboot, Lock, Set PW, Wipe)
- Sensor collection from devices
- Cursor-on-Target (CoT) support

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